	Type	L #	Hits	Search Text	DBs	Time Stamp
1	IS&R	L2	2	(("4033725") or ("5285628")).PN.	USPAT	2005/03/09 17:10
2	IS&R	L3	7	(("3,873,671") or ("4,846,665") or ("5,302,111") or ("5,356,213") or ("5,522,721") or ("6,109,911") or ("6,718,772")).PN.	USPAT	2005/03/09 17:10
3	IS&R	L4	1	("4,583,936").PN.	USPAT	2005/03/09 17:10
4	IS&R	L1	5	(("5,765,323") or ("6,202,700") or ("3,287,866") or ("4,590,722") or ("5,660,008")).PN.	USPAT	2005/03/09 17:10
5	BRS	L5	10	L2 L3 L4	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/03/09 17:29
6	BRS	L6	6	("5356213").URPN.	USPAT	2005/03/09 17:11
7	BRS	L7	21	("2816518" | "3249341" | "3675901" | "3734111" | "3818938" | "4007969" | "4038186" | "4258782" | "4344752" | "4474477" | "4487553" | "4519423" | "4521117" | "4623521" | "4674888" | "4761077" | "4850702" | "4869595" | "5131757").PN.	US-PGPUB; USPAT; USOCR	2005/03/09 17:25
8	BRS	L8	18	("5285628").URPN.	USPAT	2005/03/09 17:26

	Type	L #	Hits	Search Text	DBs	Time Stamp
9	BRS	L9	18	("3359723" | "3859786" | "4102125" | "4173118" | "4201047" | "4214435" | "4382771" | "4688521" | "4787208" | "4819438" | "4830604" | "4860695" | "4879959" | "4920925" | "4989549" | "5002483" | "5029557").PN.	US-PGPUB; USPAT; USOCR	2005/03/09 17:27
10	BRS	L10	11055	(mix or mixing or mixture) and (CO or carbon adj dioxide) and (NOS or NOx or nitrous adj oxide) and (combust or combustion or combusting or combustor) and zone and (inject or injection or injecting or injector)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/03/09 17:35
11	BRS	L11	1287	(mix or mixing or mixture) and (CO or carbon adj dioxide) and (NOS or NOx or nitrous adj oxide) and (combust or combustion or combusting or combustor) and zone and (inject or injection or injecting or injector) and (oxidant or oxidize or oxidizing or oxidation) and (recirc or recirculation or recirculating)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/03/09 17:37

	Type	L #	Hits	Search Text	DBs	Time Stamp
12	BRS	L12	803	(mix or mixing or mixture) and (CO or carbon adj dioxide) and (NOS or NOx or nitrous adj oxide) and (combust or combustion or combusting or combustor) and zone and (inject or injection or injecting or injector) and (oxidant or oxidize or oxidizing or oxidation) and (recirc or recirculation or recirculating) and (downstream or after adj stage or afterburn)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/03/09 17:38
13	BRS	L13	92	(mix or mixing or mixture) and (CO or carbon adj dioxide) and (NOS or NOx or nitrous adj oxide) and (combust or combustion or combusting or combustor) and zone and (inject or injection or injecting or injector) and (oxidant or oxidize or oxidizing or oxidation) and (recirc or recirculation or recirculating) and (downstream or after adj stage or afterburn) and (post adj combustion or after adj combustion)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/03/09 17:38
14	BRS	L14	182	11 and "431"/$.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/03/09 17:38

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15	BRS	L15	961	10 and "431"/$.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/03/09 17:38
16	BRS	L16	140	12 and "431"/$.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/03/09 17:39
17	BRS	L17	28	13 and "431"/$.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	2005/03/09 17:39
18	BRS	L18	0	("6607376").URPN.	USPAT	2005/03/09 17:39
19	BRS	L19	11	("2762428" | "3182712" | "3639095" | "3684424" | "4257762" | "4702691" | "5131838" | "5271729" | "5338186").PN.	US-PGPUB; USPAT; USOCR	2005/03/09 17:39

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... Title: Separated Jet Oxy-Fuel Burner for Ultra Low **NOx** Emissions and Uniform
Heat Transfer. Company: American **Air Liquide**. Presenter: Mike Joshi ...
http://www.gmic.org/advancesglass.htm - Cached

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... The first FCCU oxygen enrichment application for **Air Liquide** began in the
early 1980's. ... Pollution control (**NOx**, **CO** and particulates), ...
http://www.us.airliquide.com/en/business/industry/oil_gas/solutions/downstream/other_products.asp - Cached

Features Item: Oscillating Combustion Technology Boosts Furnace ...
... burners can run on different duty cycles to optimize **CO** and **NOx** emissions.
... Gas Applications, **Air Liquide** America **Co.**, 5230 SE Ave., Countryside, ...
http://www.industrialheating.com/CDA/ArticleInformation/features/BNP__Features__Item/0,2832,20588,00.html - C

Features Item: Oscillating Combustion Technology Being Evaluated ...
... Southern California Gas Company, the Institute of Gas Technology, ...
with oxy-gas at **Air Liquide**, up to 70% reductions in **NOx** have been measured. ...
http://www.industrialheating.com/CDA/ArticleInformation/features/BNP__Features__Item/0,2832,9959,00.html - Ca

Emissions Detectors Information at Business.com
... process and ambient **air** analyzers, as well as automated **liquid** analyzers for...
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http://www.business.com/directory/industrial_goods_and_services/industrial_supplies/detectors/emissions_detectc

Annual Reports 2002 - 2003
... **CO**, **NOx** and **CO2** emissions of over 350 tonnes per year. ... all operated by

neighbouring **Air Liquide** Canada Inc. Thanks to the new plant, ...
http://oee.nrcan.gc.ca/publications/infosource/pub/cipec/AnnualReport02-03/annualReport-20.cfm?text=N&printvie

NETL's TechNews: DOE Selects Five **NOx**-Control Projects to Combat ...
... The Babcock & Wilcox Company, Barberton, Ohio Advanced In-Furnace **NOx** ...
Along with **co**-participant American **Air Liquide**, Babcock & Wilcox will use a ...
http://www.netl.doe.gov/publications/TechNews/tn_rain-smog.html - Cached

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Advances in Combustion Technologies for Glass Processing

Produced by

Glass Manufacturing Industry Council

The Westmoreland Room

David L. Lawrence Convention Center

Pittsburgh, PA, USA

May 2, 2000

GMIC Workshop

Pittsburgh, PA

Program

Advances in Combustion Technologies

for Glass Processing

Time Topic

1:00 Introduction – Michael Greenman – GMIC

1:05 – 2:10 PM

Panel 1 -- General Session – Overview of Combustion in the Glass Industry

Chair - Bob Gemmer - DOE

Title: Principles of Glass Melting which Help to Define Objectives of the Combustion Process.

Company: Glass Industry Consulting

Presenter: Phil Ross

Significant attention in recent years has focused on new burners and furnace design issues for glass making, especially oxy-fuel. This presentation will review principles involved in the melting of raw materials into glass and how combustion considerations should relate to resultant operating productivity, efficiency and glass quality.

Title: Combustion RD&D at the US DOE Office of Industrial Technology

Company Department of Energy

Presenter: Bob Gemmer

An overview of the Industries of the Future will be provided, focusing on the Glass Industry Program. The general role of cross cutting technologies will be described, followed by a discussion of overall activities in the Combustion Program. The presentation will conclude with specific examples of combustion technologies being developed for the glass industry.

Title: A Glass Furnace Combustion and Melting User Research Facility

Company: Sandia National Laboratories

Presenter: Bob Gallagher

The Combustion Research Facility at Sandia National Laboratories, Livermore CA has been selected by the US Department of Energy's Office of Industrial Technologies as the location for its Glass Furnace Combustion and Melting User Research Facility. Designed to take advantage of the advanced combustion and high temperature diagnostics already available within the CRF, the facility will be available to all segments of the US Glass Industry. Operated by Sandia, the glass user facility's research agenda will be developed and executed in a collaborative manner with industrial partners. While it is envisioned that much of the work will be of a pre-competitive nature, provisions will be made for company funded proprietary work as well. A DOE approved board of industry representatives will provide oversight.

Research on the following aspects of furnace performance is envisioned: 1) Measurement of gaseous species concentrations in the combustion space, 2) Progress of batch reactions and melting, 3) Combustion control, and 4) Sensors. Other areas will be added as the needs of industrial participants dictate. Visits by industry engineers and scientists lasting from a few hours to many months will be encouraged.

Title: Future Burner and Furnace Design Challenges

Company: Fusetech, Inc.

Presenter: Don Shamp

Ceramic welding allows an opportunity to talk with furnace operators and observe different furnace designs during production. This is a short synopsis of operators' remarks and observations made on furnaces. It is hoped that this may help explain some of the problems operators still face, and possible design aids.

Questions/Answers

2:10 – 3:40 PM

Panel 2 - Burners –

<u>Advanced Oxy-fuel and Air-fuel Combustion Technologies</u>

Chair – Hamid Abbasi - IGT

Title: A New Air Gas, Low NOx Burner for the Glass Industry

Company: Eclipse/Combustion Tec

Presenter: Daniel B. Wishnick

While oxy fuel technology generally takes center stage at any glass group gathering, a large sector of our industry still relies on air gas technology. To support the air gas sector, a new air gas burner has been designed to meet low NOx requirements and improve the combustion performance of current day installations. This presentation will discuss air gas technology and the development path for this new burner.

Title: The Design & Placement of Oxy-Fuel Burners

to Improve Quality of Glass Melting

Company: BOC Gases & Maxon Corporation

Presenters: Neil G. Simpson and Dan Ertl

The energy savings and potential increases in melting capacity related to Oxy-Fuel combustion in glass melting furnace applications has been previously identified. This paper highlights the improvements in glass quality which can be achieved specifically related to the selection of oxy-fuel burners and placement in the glass melter. With reference to case studies, the importance of burner angles in maximizing heat transfer and obtaining glass quality improvements will be discussed. The experiences gained are valuable in the development of the next generation of Oxy-Fuel burners.

Title: Separated Jet Oxy-Fuel Burner for Ultra Low NOx Emissions and Uniform Heat Transfer

Company: American Air Liquide

Presenter: Mike Joshi

Authors: M. Joshi, O. Marin, H. Borders and O. Charon and R. Tsiava, Air Liquide, Les Loges-

en-Josas, France

This effort presents laboratory tests and industrial results of a novel flat flame oxy-fuel burner designed for glass melting applications. The unique aspects inherent with a separated jet flame design include lower mixing velocities, massive entrainment of combustion products into the flame core and staged combustion. The paper highlights key operational results such as higher productivity, lower refractory (crown and side-wall) temperatures, lower volatilization, lower particulate and NOx emissions and improved batch line control.

Title: High-Luminosity Burner for Oxy-Gas Glass Melters – Testing and Modeling

Company: Institute of Gas Technologies

Presenter: David Rue

Authors: David Rue, Serguei Nester, Hamid Abbasi: Institute of Gas Technology; Patrick Mohr, Ad de Pijper: Eclipse Combustion

A high-luminosity oxy-gas burner has been developed to provide high radiation heat transfer to the glass and low NO_x emissions. Soot precursors are formed by precombustion and direct mixing. The soot is formed and burned out in a flat flame with fuel-rich and fuel-lean zones. Commercial prototype burner testing is scheduled for this spring at Eclipse Combustion and this summer on an Owens Corning fiberglass furnace.

Title: Cleanfire® AOF Technology

Company: Air Products and Chemicals, Inc.

Presenter: Aleksandar Slavejkov

Authors: A. Slavejkov, B. C. Hoke, M. D. D'Agostini, K. A. Lievre

The Cleanfire HR burner is the oxy-fuel burner of choice by many glass manufacturers, especially for high quality glass melting. The burner provides a low momentum, luminous flame for enhanced heat transfer to the glass. A new development, the Cleanfire AOF burner (patent pending), permits both air-fuel and oxygen enriched air-fuel combustion of natural gas and fuel oil. This paper will describe the new technology and discuss how it can ensure continuity of glass production in the event of oxygen supply disruption.

Title: Combining Oxy-Fuel Improvements for Maximum Advantage

Company: Praxair

Presenter: William Snyder

Authors: Ron Schroeder, Bill Snyder, KT Wu – Praxair Inc.

Through much of the 1990's increased experience with oxy-fuel firing of glass furnaces has driven new technology development in several directions. Initiatives have been undertaken to improve burners, extend refractory life, reduce emissions, increase productivity and recover waste energy. These technologies have been evaluated on an individual basis as glass manufacturers look for improvements to their process. Results from some of these individual initiatives will be discussed and the benefits of utilizing two or more of them in a single furnace will be reviewed.

Questions/Answers

3:40 – 3:55 PM Break

3:55 – 5:00 PM

Panel 3 - Controls –

<u>**Advanced Sensors and Process Control Technologies**</u>

Chair – Mike Joshi (American Air Liquide)

Title: Combustion Control by CO/NOx Sensoring and Prediction of Volatilization and for the Reduction of NOx Emissions and Na–Volatilization In-situ

Company: TNO

Presenter: Ing H.J. Koch

Authors: Ing H.J. Koch, Ing J.A.C. van Limpt and Drs A.J. Faber

CO-monitoring is a useful technique. In the paper I will present the development of a measurement technique for the CO in-situ sensor, based on a near IR-laser absorption principle. Next to this I will present the effects of reducing atmosphere on the Na-volatilization.

Title RSC (Real-time Statistical Control).

Company: Advanced Control Systems Inc.

Presenter: Ron Finch

Authors: Ron Finch, Alan White

ACSI has developed a new control algorithm called RSC (Real-time Statistical Control). RSC is based on the application of statistics to real-time process control. This strategy has proven beneficial for in-glass conditioning applications, such as in-glass temperature control, automatic cooling control, and melter temperature control. RSC utilizes standard SPC rules and applies them in real time to make adjustments in the control system.

Title: Analysis of Control Systems for Glass Furnace Applications

Company: Matrix Technologies

Presenter: Tim Stout

Traditional control systems for glass production facilities are obsolete from a cost and technology standpoint. This paper analyses three available options for achieving the same degree of control on glass processes. The control systems analyzed are DCS, PLC/HMI and the newer Hybrid controls. Engineering, programming and operational requirements are reviewed. The economics for initial installation and lifecycle costs are compared for all three options.

Title: Supervisory Advanced Control for Temperature Stability, Increased Productivity, Energy Efficiency and Reduced Emissions

Company: Glass Services, Ltd.

Presenter: Erik Muysenberg

Authors: Erik Muysenberg and Josef Chmelar

The present state of furnace control in the glass industry is poor, therefore the potential increase in benefits by advanced control based on Expert Systems is high. These supervisory systems can increase temperature stability, productivity, energy efficiency and reduce emissions together with less operator actions.

Questions/Answers

Conclusion – Michael Greenman - GMIC

5:00 – 5:05 PM

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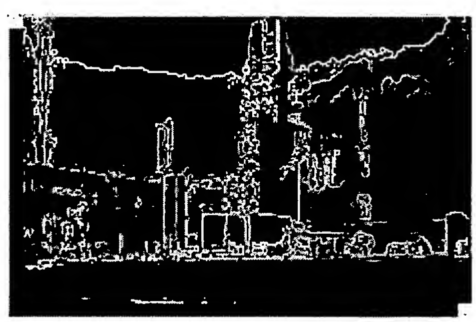
• Nitrogen applications

Nitrogen is used primarily to ensure safe processes and maintain product quality. Nitrogen is typically used for blanketing storage tanks. During shutdown periods, compressors, pipelines and reactors may be inerted to prevent equipment degradation. Nitrogen can also be used for pressure transfer of products between storage vessels, units or into shipping (transport) vessels.

Nitrogen can be supplied in different modes, including cylinders, bulk liquid, onsite membrane units (Floxal™), onsite cryogenic assisted units (Floxal™, APSA™), and via pipeline supply.

Feedstock capacity expansion projects and processing of resid feeds in Fluid Catalytic Cracking Units (FCCUs) continues to grow. The number of FCCU's utilizing oxygen to achieve these objectives is more than 25 worldwide. Refiners have used pure oxygen to enrich the FCCU regenerator combustion air up to 28% volume. This technology should lead to a capacity increase of over 25% or a resid increase of 10%. The modifications required to install the oxygen injection apparatus are minor and can be performed between unit turnarounds.

• FCCU oxygen enrichment



The first FCCU oxygen enrichment application for Air Liquide began in the early 1980's. Air Liquide has taken a leading role in the successful implementation of oxygen enrichment for FCCUs by providing the essential oxygen and injection devices, effective safety management, reliable and accurate flow skids and detailed process evaluations.

The overwhelming benefit of utilizing oxygen enrichment for the FCCU is to increase its profitability without having to shut down to carry out modifications. This increase in profitability is due to:

- Increasing unit throughput
- Processing cheaper crudes

- Increasing gasoline yield
- Reducing emissions

Oxygen enrichment is typically used to overcome a limitation in regenerator coke burning. The oxygen is used when some equipment limits the quantity of air needed to burn coke from the spent catalyst. Oxygen enrichment can overcome this by improving the performance of certain equipment and process conditions, such as:

- Combustion air blower limitation
- Air distribution
- Superficial velocity
- Inlet cyclone velocity
- Coke on regenerated catalyst
- Incomplete combustion (carbon monoxide destruction).

A careful evaluation of the FFCU equipment will determine the quantity of oxygen required to meet the refiner's objectives. The maximum quantity of oxygen that can be applied is generally determined by temperature limitations on high regenerators, superficial velocity on downstream equipment, such as the main fractionator capacity, wet gas compressor or gas recovery unit.

Our proprietary simulation software can provide an estimate of the potential benefits and limitations on your units. Once the model is calibrated, the model can be used to estimate the required oxygen level that will maximize refiner benefits. The amount of oxygen required will also indicate what type of supply mode will be best for the application.

The benefits for the refiner process depend on the issues highlighted above together with equipment constraints on the unit. Our clients have measured benefits from between $4,000 and $25,000 per day. Contact us for an evaluation of the benefits of oxygen enrichment for your site. We can also tell you about existing case studies and some of the new technologies we are developing.

■ TOP

• SRU oxygen enrichment

Technologies using oxygen to expand the capacity of Claus Sulfur Recovery Units (SRU) or to build peak shaving process capability into new units are now widespread in the refining industry. Oxygen use in SRUs provides more than just capacity advantages, it can increase the combustion efficiency of the furnace and in some cases the overall sulfur recovery efficiency of the sulfur facility. If the refinery processes ammonia bearing sour water stripper gas, SRU's are often faced with ammonium salt formation and pluggage by these salts in heat exchange equipment. The use of oxygen can help promote the destruction of ammonia and ensure that ammonium salt formation is minimized. Oxygen can also help in the combustion of lean acid gas feeds.

Oxygen enrichment to 28% volume

Oxygen enrichment involves blending an oxygen rich stream into a combustion air line to increase the air stream up to a maximum of 28% volume. The system is quite inexpensive, usually requiring oxygen supply equipment, a control skid, a sparger (Air Liquide's Oxynator™), and associated piping. Enrichment can typically be implemented without any modifications to the existing burner. The capacity increase that can be achieved through oxygen enrichment ranges from 25 to 30%. Oxygen

enrichment can be applied in virtually any SRU. Our references indicate that no modifications are required downstream of the furnace. If expansion of over 30% is required, you should consider making a detailed analysis of all equipment in the sulfur and tailgas units. At Air Liquide, we work with qualified engineering firms to implement such projects.

With oxygen enrichment, installation can occur without any interruption to the operation of the SRU. The air line can be hot-tapped between turnarounds or cold-tapped in a previous turnaround. The Oxynator™ can be installed at any time through a full port valve that has been sized for the apparatus. An oxygen flow control skid and supply system can be installed prior to any process changes to the unit. Once all the equipment is in place, oxygen can be introduced into the SRU to improve its performance.

Oxygen enrichment greater than 28% volume and ammonia destruction

At Air Liquide, we have developed a unique burner (Oxyburner™) to help refiners to completely destroy ammonia in feeds to SRU's. This burner allows greater than 28% oxygen enrichment, up to 100% concentration to increase SRU capacity, ensure ammonia destruction with a turndown of 7:1 on air. The burner can easily retrofit existing SRU furnaces.

• SAROX, oxygen enrichment for sulfuric acid regenerator units

Oxygen has become widely used to increase capacity, reduce emissions and increase profits of air-based industrial processes since the early 1980's. Oxygen enrichment has been used to overcome limitations on existing equipment, reduce flue gas volumes, and increase reaction conversions.

Oxygen enrichment of Sulfuric Acid Regenerators (SAR) is beneficial in the regenerator furnace for increase acid throughput in a regenerator furnace, and to increase sulfur dioxide (SO_2) conversion and reduce emissions in the converter. These benefits translate into; increasing unit capacity at a minimal investment, reduction of capital required for a new SAR plant and reduced emissions.

Air Liquide has developed and validated its own technologies through industrial references, enabling us to determine the optimum use of oxygen in the application aforementioned. From intermittent peak shaving to doubling the capacity of air based units, SAROX™ technology is usually justified (partially or totally) by fuel savings. SAROX™ can be used in simple and double adsorption processes.

The SAROX™ process typically requires several oxy-fuel burners on the combustion furnace. Computational Fluid Dynamics is used to determine the placement of the burners, determine residence time distribution, identify hot spots and improve heat transfer within the furnace.

■ TOP

• Oxy-fuel operation and simulation

Oxygen enrichment is the practice of combining a concentrated oxygen stream with an air stream. The oxygen stream enters the air piping through a sparger or mixing device. This is usually

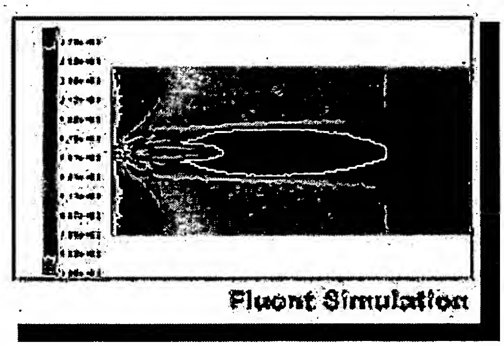
located upstream of the combustion apparatus. Air Liquide's patented Oxynator™ sparger allows pure oxygen to combine safely with the combustion air. The Oxynator™ is a swirl-type sparger, which introduces oxygen at the center of an air pipe and imparts spin in order for the mixing of oxygen and air to occur. The Oxynator™ is custom designed for each application. The Oxynator™ can be installed in a clean or potentially contaminated (with hydrocarbons) air piping system. The design of the sparger must follow two strict guidelines; to minimize mixing length and avoid high oxygen concentrations near pipe walls.

The maximum allowable oxygen concentration of 28% volume will be the upper limit for oxygen mixing in non-oxygen service piping. Plans for increasing the limit will have to be evaluated on a case by case basis. The oxygen limit exists to prevent any hazardous situation whereby flammable hydrocarbons can ignite. The Oxygnator™ ensures homogeneous oxygen and air mixing within the pipe.

When oxygen concentrations above 28% are required to satisfy process targets, oxygen can be fed directly into a furnace via a specialized oxy-fuel burner or injector. This technology allows the direct injection of oxygen into the combustion zone without contacting contaminated piping or equipment. Oxygen injection is then limited by combustion temperature or downstream capacity constraints.

- **Air Liquide simulation**

Air Liquide supplies oxy-fuel combusters and injectors to various furnace applications. Our process and fluid flow modeling helps ensure optimal burner location to maximize efficiency and prevent hot-spots. In-house codes developed for FCCU, SRU, sulfuric acid regenerators have all been validated. Commercially available codes such as Aspen and Sulsim are also utilized for more general applications.



- **Athena combustion modeling**

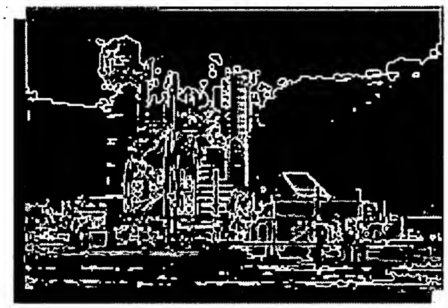
Athena is a state of the art model that simulates oxy-fuel furnace conditions. Athena's capabilities help to optimize a process prior to furnace modification for maximum oxy-fuel benefits. Athena modeling uses a 3D computational fluid dynamics (CFD) and heat transfer code that calculates the effect of combustion and radiation in participating media. Air Liquide uses Athena in conjunction with other commercially available codes to simulate processes. Athena based solutions are displayed in 3D color maps that detail important parameters such as localized refractory temperatures, combustion atmosphere temperatures, hot/cold spots, streamlines, gas residence time distributions, gas velocity

fields, pressure and species concentration.

The benefits provided by these simulation tools include:

- Capital and operating cost savings,
- Pollution control (NOx, CO and particulates),
- Heat transfer and reaction conversion enhancement, and
- Flame stability improvement.

• **Cogeneration in refineries**



Cogeneration of power and steam can help refiners meet new environmental mandates for NOx and SOx limits. Refineries may be operating with old fuel oils based boilers requiring extensive maintenance and monitoring. Cogeneration units can provide a certain amount of independence from electricity grid pricing, if properly designed and managed. Cogeneration is superior to stand alone boiler systems and steam turbine electricity generation due to increased efficiencies, resulting in less emissions and carbon dioxide releases to the atmosphere.

Air Liquide owns and operates over 1400 MW of cogeneration produced power. New projects due to start in the near future will raise cogenerated power production to 2000 MW. We offer expertise in the development, integration, design, implementation and operation of a cogeneration system. We can also provide in-house engineering and construction management as well as internal funding or project financing.

Air Liquide can help the refiner re-evaluate and operate their utility systems. We are focused on improving the reliability of the refiner's utilities in the following sectors:

- De-mineralized water
- Process water
- Industrial gases
- Industrial water treatment
- Industrial process steam
- Plant operation and maintenance
- Electricity management
- Fuel supply management
- Facility development

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